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10/824,751

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EXAMINER

SAVLA, ARPAN P

ART UNIT

PAPER NUMBER

2185

DATE MAILED: 05/05/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

<b>Office Action Summary</b>	<b>Application No.</b> 10/824,751	<b>Applicant(s)</b> DUSSUD, PATRICK H.	
	<b>Examiner</b> Arpan P. Savla	<b>Art Unit</b> 2185	

**-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --**  
**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

#### Status

- 1) ☒ Responsive to communication(s) filed on 15 April 2004.
- 2a) ☐ This action is **FINAL**.                      2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

#### Disposition of Claims

- 4) ☒ Claim(s) 1-24 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-24 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

#### Application Papers

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 15 April 2004 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

#### Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).  
a) ☐ All    b) ☐ Some \*    c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

#### Attachment(s)

- |  |   |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)  | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)   | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)             |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)<br>Paper No(s)/Mail Date <u>5/18/04, 4/21/05, 6/3/05, 9/23/05</u> | 6) <input type="checkbox"/> Other: _____  |

### **DETAILED ACTION**

The instant application having Application No. 10/824,751 has a total of 24 claims pending in the application, there are 3 independent claims and 21 dependent claims, all of which are ready for examination by Examiner.

### **INFORMATION CONCERNING OATH/DECLARATION**

#### **Oath/Declaration**

1. Applicant's oath/declaration has been reviewed by Examiner and is found to conform to the requirements prescribed in 37 CFR 1.63.

### **INFORMATION CONCERNING DRAWINGS**

#### **Drawings**

2. Applicant's drawings submitted April 15, 2004 are acceptable for examination purposes.

### **ACKNOWLEDGMENT OF REFERENCES CITED BY APPLICANT**

#### **Information Disclosure Statement**

3. As required by MPEP § 609(c), Applicant's submission of the Information Disclosure Statements dated May 18, 2004, April 21, 2005, June 3, 2005, and September 23, 2005 are acknowledged by Examiner and cited references have been considered in the examination of the claims now pending. As required by MPEP § 609

c(2), a copy of the PTOL-1449 initialed and dated by Examiner is attached to the instant office action.

## **OBJECTIONS**

### **Specification**

4. The title of the invention is not descriptive. A new title is required that is clearly indicative of the invention to which the claims are directed.

The following title is suggested: "System and Method for Performing Ephemeral Garbage Collection on a Large Heap Using Marked Cards and Card Table Memory."

5. The specification is objected to as failing to provide proper antecedent basis for the claimed subject matter. See 37 CFR 1.75(d)(1) and MPEP § 608.01(o). Correction of the following is required: The subject matter in question is disclosed in claim 18. The claim calls for tracking to be performed on an initial access to the card table memory and not upon subsequent accesses to the card table memory. However, this subject matter does not appear in Applicant's specification. Paragraph 0017, lines 6-8 of Applicant's specification discloses a "write-watch" mechanism that tracks the first access to a **memory location** and does not track subsequent accesses to the **same memory location**. However, this portion of the specification is narrower in scope than the claimed subject matter of claim 18. For the purposes of this instant office action Examiner will interpret claim 18 to refer to tracking to be performed on an initial access to a (specific) memory location in the card table memory and not upon subsequent accesses to the same (specific) memory location in the card table memory.

**REJECTIONS NOT BASED ON PRIOR ART**

**Claim Rejections - 35 USC § 101**

6. 35 U.S.C. 101 reads as follows:

Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

7. **Claims 1-11 are rejected under 35 U.S.C. 101 because the claimed invention is directed to non-statutory subject matter.** Claims 1-11 are not limited to tangible embodiments. In view of Applicant's disclosure, paragraphs 0023 and 0025, the computer readable medium is not limited to tangible embodiments, instead being defined as including both tangible embodiments (e.g. RAM, ROM, EEPROM, flash memory or other memory technology, CD-ROM, digital versatile disks (DVD) or other optical storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices) and intangible embodiments (e.g. modulated data signal, such as a carrier wave or wireless media such as acoustic, RF, infrared and other wireless media, etc.). As such, claims 1-11 are not limited to statutory subject matter and are therefore non-statutory.

8. **Claims 19-24 are rejected under 35 U.S.C. 101 because the claimed invention is directed to non-statutory subject matter.** Claim 19 recites both an apparatus and the method steps of using the apparatus. Therefore, this rejection is based on the theory that the claim is directed to neither a "process" nor a "machine," but rather embraces or overlaps two different statutory classes of invention set forth in 35 U.S.C. 101 which is drafted so as to set forth the statutory classes of invention in the

alternative only. Id. at 1551. See MPEP § 2173.05(p), Section II entitled "PRODUCT AND PROCESS IN THE SAME CLAIM."

**Claim Rejections - 35 USC § 112**

9. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

10. **Claim 18 is rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement.** The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. The subject matter in question is disclosed in claim 18. The claim calls for tracking to be performed on an initial access to the card table memory and not upon subsequent accesses to the card table memory. However, this subject matter does not appear in Applicant's specification. Paragraph 0017, lines 6-8 of Applicant's specification discloses a "write-watch" mechanism that tracks the first access to a **memory location** and does not track subsequent accesses to the **same memory location**. However, this portion of the specification is narrower in scope than the claimed subject matter of claim 18. For the purposes of this instant office action Examiner will interpret claim 18 to refer to tracking to be performed on an initial access to a (specific) memory location in the card table memory and not upon subsequent accesses to the same (specific) memory location in the card table memory.

11. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

12. **Claims 19-24 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.** A single claim which claims both an apparatus and the method steps of using the apparatus is indefinite under 35 U.S.C. 112, second paragraph. Ex parte Lyell, 17 USPQ2d 1548 (Bd. Pat. App. & Inter. 1990). See MPEP § 2173.05(p), Section II entitled "PRODUCT AND PROCESS IN THE SAME CLAIM."

13. **Claims 22-24 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.** The claims recite the limitations "The computer-readable medium of..." in line 1 of each respective claim. There is insufficient antecedent basis for these limitations in the claims. Applicant may consider amending the claims to read "The system of..."

## **REJECTIONS BASED ON PRIOR ART**

### **Claim Rejections - 35 USC § 102**

14. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the

applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

**15. Claims 1-4, 6, 8, and 19-22 are rejected under U.S.C. 102(e) as being anticipated by Nagarajan et al. (U.S. Patent Application Publication 2004/0003014).**

**16. As per claim 1**, Nagarajan discloses a computer-readable medium having computer-executable instructions for performing ephemeral garbage collection (paragraph 0026, lines 1-5), the instructions comprising:

obtaining a list of memory locations that have been written into since the last ephemeral garbage collection (paragraphs 0040, lines 1-5; Fig. 4, element 410), each memory location corresponding to one of a plurality of addresses for accessing a card table that identifies marked cards (paragraph 0038, lines 1-4; paragraph 0030, lines 1-2; Fig. 2, element 204; Fig. 4), the marked cards being associated with one or more objects allocated from within a memory heap (paragraph 0034, lines 5-8; paragraph 0028, lines 1-2; Fig. 2; *note the segments are associated with one or more objects and the segments are comprised of cards*), the memory heap being divided into a plurality of cards which are grouped into a plurality of bundles (paragraph 0010, lines 3-6), each marked card being one of the plurality of cards (paragraph 0010, lines 4-7); *It should be noted that "generational" is analogous to "ephemeral" and "segment" is analogous to "bundle."* *It should also be noted that the "card table addresses" directly correspond to "pointer addresses" needing to be updated (paragraphs 0037-0040), therefore, the "card table addresses" are analogous to the "list."*



identifying at least one marked bundle out of the plurality of bundles based on the list (paragraph 0042, lines 5-7; Fig. 5, element 504);

for each marked bundle, determining the marked cards within the marked bundle (paragraph 0042, lines 7-10; Fig. 5, element 506);

for each marked card, determining at least one accessed object within the marked card (paragraph 0035, lines 2-4; paragraph 0044, lines 4-6; Fig. 6, element 602); *It should be noted that a marked entry in the card table indicates an object in the old generation has been accessed (i.e. updated).*

and performing garbage collection upon the at least one accessed object (paragraph 0044, line 6 – paragraph 0045, line 5; Fig. 6, elements 604, 606, 608, 610, and 612).

17. **As per claim 2**, Nagarajan discloses obtaining the list of memory locations comprises requesting the list from a write-watch mechanism (paragraph 0038, lines 4-6; paragraph 0040, lines 3-5; paragraph 0044, lines 4-6; Fig. 3, elements 304 and 310; Fig. 6, element 602). *It should be noted that “reference updating mechanism” is analogous to “write-watch mechanism.” It should also be noted that “garbage collector” must request the “reference updating mechanism” and subsequently the “card table address” because the “garbage collector” promotes objects based on the marked card table which is in turn based on the “card table address.”*

18. **As per claim 3**, Nagarajan discloses the write-watch mechanism operates within a memory manager (paragraph 0030, lines 8-10; Fig. 3, elements 302 and 304). *It should be noted that the “virtual machine” acts as a “memory manager” in that the*

*“virtual machine” performs the functions of updating the card table entries and also allocating memory segments (via the reference updating mechanism and memory allocator respectively).*

19. **As per claim 4**, Nagarajan discloses the write-watch mechanism records a first access to the memory location (paragraph 0042, lines 3-5; Fig. 5, element 502).

20. **As per claim 6**, Nagarajan discloses the list of memory locations is maintained in response to a request from the ephemeral garbage collection process (paragraph 0044, lines 4-6; Fig. 6, element 602). *It should be noted, as mentioned above, that the “garbage collector” must request the “reference updating mechanism” and subsequently the “card table address” because the “garbage collector” promotes objects based on the marked card table which is in turn based on the “card table address.”*

21. **As per claim 8**, Nagarajan discloses the group of cards grouped into each bundle corresponds to a number of cards that are tracked using a page of memory storing the card table (paragraph 0010, lines 4-7).

22. **As per claim 19**, Nagarajan discloses a system for performing ephemeral garbage collection, the system comprising:

a processor (see below);

and a memory into which a plurality of instructions are loaded (see below) and into which a plurality of objects are dynamically allocated (paragraph 0004, lines 1-3), the memory having a heap into which the objects are allocated (paragraph 0004, lines 1-3), the heap being divided into a plurality of cards which are grouped into a plurality of bundles (paragraph 0010, lines 3-6), each card being associated with one or more of

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the plurality of objects (paragraph 0034, lines 5-8; *note the segments are associated with one or more objects and the segments are comprised of cards*), *It should be noted that for any computer system it is inherently required a processor and some type of memory into which a plurality of instructions are loaded be present in order for the computer system to function. Also, please see the citation notes for the similar limitation in claim 1 above.*

the plurality of instructions performing a method comprising:

during a garbage collection cycle, obtaining a list of memory locations that have been written into since the last garbage collection cycle (paragraphs 0040, lines 1-5; Fig. 4, element 410), each memory location corresponding to one of a plurality of addresses for accessing a card table that identifies marked cards (paragraph 0038, lines 1-4; paragraph 0030, lines 1-2; Fig. 2, element 204; Fig. 4), each marked card being one of the plurality of cards (paragraphs 0040, lines 4-7);

identifying at least one marked bundle out of the plurality of bundles based on the list (paragraph 0042, lines 5-7; Fig. 5, element 504);

for each marked bundle, determining at least one marked card within the marked bundle the at least one marked card indicating that one or more objects associated with the marked card has been accessed (paragraph 0042, lines 7-10; Fig. 5, element 506); *It should be noted that a marked card indicates an object in the old generation has been accessed (i.e. updated).*

for each marked card, determining at least one accessed object within the marked card (paragraph 0035, lines 2-4; paragraph 0044, lines 4-6; Fig. 6, element 602); *Please see the citation note for the similar limitation in claim 1 above.*

and performing garbage collection upon the at least one accessed object (paragraph 0044, line 6 – paragraph 0045, line 5; Fig. 6, elements 604, 606, 608, 610, and 612).

23. **As per claim 20**, Nagarajan discloses obtaining the list of memory locations comprises requesting the list from a write-watch mechanism (paragraph 0038, lines 4-6; paragraph 0040, lines 3-5; paragraph 0044, lines 4-6; Fig. 3, elements 304 and 310; Fig. 6, element 602). *Please the citation note for claim 2 above.*

24. **As per claim 21**, Nagarajan discloses the write-watch mechanism resides within a memory manager (paragraph 0030, lines 8-10; Fig. 3, elements 302 and 304). *Please see citation note for claim 3 above.*

25. **As per claim 22**, Nagarajan discloses the group of cards grouped into each bundle corresponds to a number of cards that are tracked using a page of memory storing the card table (paragraph 0010, lines 4-7).

### **Claim Rejections - 35 USC § 103**

26. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

**27. Claims 5 and 7 are rejected under 35 U.S.C. 103(a) as being obvious over Nagarajan in view of Alpern (U.S. Patent 6,510,440).**

**28. As per claim 5, Nagarajan discloses all of the limitations of claim 5 except the write-watch mechanism does not record subsequent accesses to the same memory location.**

Alpern discloses the write-watch mechanism does not record subsequent accesses to the same memory location (col. 9, lines 10-15; Fig. 7, element 710). *It should be noted that "visited" is analogous to "access." It should also be noted that by "returning to the calling function" the memory location is not marked (i.e. the subsequent access is not recorded) as opposed to step 730 (col. 9, lines 29-30; Fig. 7, element 730).*

Nagarajan and Alpern are analogous art because they are from the same field of endeavor, that being garbage collection.

At the time of the invention it would have been obvious to a person of ordinary skill in the art to implement Alpern's barrier bit within Nagarajan's garbage collector.

The motivation for doing so would have been to increase system efficiency and decrease system size by having a barrier bit associated with each object to differentiate generations in the generational garbage collection scheme and also keeping the write buffer small by eliminating duplicate entries (Alpern, col. 5, lines 34-36 and 44-45).

Therefore, it would have been obvious to combine Nagarajan and Alpern for the benefit of obtaining the invention as specified in claim 5.

29. **As per claim 7**, Alpern discloses resetting the list of memory locations (col. 9, lines 3-5; Fig. 4, element 175; Fig. 6, element 650). *It should be noted that "write buffer" is analogous to "list of memory locations" and "deleting" is analogous to "resetting."*

30. **Claims 9-10 and 23-24** are rejected under 35 U.S.C. 103(a) as being obvious over Nagarajan in view of Patrick G. Sobalvarro "A Lifetime-based Garbage Collector for LISP Systems on General-Purpose Computers," hereafter "Sobalvarro."

31. **As per claims 9 and 23**, Nagarajan discloses all the limitations of claims 9 and 23 except identifying the marked bundle comprises marking a bit associated with the marked bundle within a bundle bitmap based on the memory locations within the list.

Sobalvarro discloses identifying the marked bundle comprises marking a bit associated with the marked bundle within a bundle bitmap based on the memory locations within the list (pg. 36, section 6.1.1, paragraph 4, lines 4-6). *It should be noted that "segment" is analogous to "bundle" and "modification bit table (MBT)" is analogous to "bundle bitmap."*

Nagarajan and Sobalvarro are analogous art because they are from the same field of endeavor, that being garbage collection.

At the time of the invention it would have been obvious to a person of ordinary skill in the art to implement Sobalvarro's MBT within Nagarajan's garbage collector.

The motivation for doing so would have been to gain pointer-storage speed on machines with 32-bit address spaces by using a two-level map (Sobalvarro, pg. 35, section 5.3, paragraph 2, lines 1-2 and 4-5).

Therefore, it would have been obvious to combine Nagarajan and Sobalvarro for the benefit of obtaining the invention as specified in claims 9 and 23.

32. **As per claims 10 and 24**, Sobalvarro discloses marking the bit comprises setting the bit (pg. 36, section 6.1.1, paragraph 4, line 6).

33. **Claim 11 is rejected under 35 U.S.C. 103(a) as being obvious over Nagarajan in view of Jones et al. "Garbage Collection, Algorithms for Automatic Dynamic Memory Management," hereafter "Jones."**

34. Nagarajan discloses all the limitations of claim 11 except determining the marked cards comprises scanning a card bitmap having a bit for each of the plurality of cards, the bit for each marked card being different than another bit associated with one of the cards that was not accessed.

Jones discloses determining the marked cards comprises scanning a card bitmap having a bit for each of the plurality of cards, the bit for each marked card being different than another bit associated with one of the cards that was not accessed (pg. 173, 1<sup>st</sup> full paragraph, lines 1-2; pg. 172, 1<sup>st</sup> full paragraph, lines 9-10). *It should be noted that "card table" is analogous to "card bitmap."*

Nagarajan and Jones are analogous art because they are from the same field of endeavor, that being garbage collection.

At the time of the invention it would have been obvious to a person of ordinary skill in the art to implement Jones's card table within Nagarajan's garbage collector.

The motivation for doing so would have been to reduce collection-time scanning because cards are smaller than pages and also reduce the amount of space occupied

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because a card table occupies less than that used in for word marking (Jones, pg. 172, 1<sup>st</sup> full paragraph, lines 3-5).

Therefore, it would have been obvious to combine Nagarajan and Jones for the benefit of obtaining the invention as specified in claim 11.

**35. Claims 12-17 are rejected under 35 U.S.C. 103(a) as being obvious over Nagarajan in view of Borman (U.S. Patent 6,845,437).**

**36. As per claim 12,** Nagarajan discloses a method for executing statements within a program to support ephemeral garbage collection, the method comprising:

the card table memory identifying marked cards that are associated with one or more objects allocated within a memory heap (paragraph 0004, lines 1-3; paragraph 0028, lines 1-2; Fig. 2), the memory heap being divided into a plurality of cards which are grouped into a plurality of bundles (paragraph 0010, lines 3-6), each marked card being one of the plurality of cards (paragraph 0010, lines 6-7);

and for each store statement within the program, storing a value at a memory location within the heap memory based on the store statement, marking one of the plurality of cards within the card table based on the memory location (paragraph 0033, lines 4-8), and tracking the card table memory (paragraph 00035, lines 2-4). *It should be noted that "updating" is analogous to "storing." It should also be noted that in order for an object in the old generation to be updated it is inherently required a "store statement" or "store instruction" dictate the update operation.*

Nagarajan does not expressly disclose specifying a range of card table memory to watch during program execution;



and for each store statement within the program, storing a value at a memory location within the heap memory based on the store statement.

Borman discloses specifying a range of card table memory to watch during program execution (col. 9, lines 4-6); *It should be noted that by eliminating range checks Borman in essence specifies the entire size of the card table as the "range."*

Nagarajan and Borman are analogous art because they are from the same field of endeavor, that being garbage collection.

At the time of the invention it would have been obvious to a person of ordinary skill in the art to implement Borman's cyclic memory space mapping within Nagarajan's garbage collector.

The motivation for doing so would have been to eliminate range checks, thus saving storage space and saving processing time (col. 9, lines 16-18 and 24-25).

Therefore, it would have been obvious to combine Nagarajan and Borman for the benefit of obtaining the invention as specified in claim 12.

37. **As per claim 13**, Borman discloses specifying the range of card table memory includes calling a write-watch mechanism that performs the tracking of the card table memory (col. 4, line 65 – col. 5, line 9; col. 7, lines 36-38; Fig. 2, element 175). *It should be noted that the "garbage collection (GC) facility" is analogous to the "write-watch mechanism" because the GC facility reviews the marked card table before completing GC process.*

38. **As per claim 14**, Borman discloses the write-watch mechanism resides within a memory manager (col. 7, lines 27-28; Fig. 2, elements 40 and 175). *It should be noted*

*that the "Java virtual machine" acts as a "memory manager" in that the "Java virtual machine" performs the function of loading classes (that represent objects) onto the heap (via the "class loaders 110").*

39. **As per claim 15**, Nagarajan discloses each bundle corresponds to a number of cards that are tracked using a page of card table memory (paragraph 0010, lines 4-7).

40. **As per claim 16**, Nagarajan discloses comprising providing a list of addresses that access the card table memory (paragraphs 0037-0040). *It should be noted that the "card table addresses" are analogous to the "list."*

41. **As per claim 17**, Nagarajan discloses an ephemeral garbage collection process requests the list when performing a garbage collection cycle (paragraph 0044, lines 4-6; Fig. 6, element 602). *It should be noted that the "garbage collector" must request the "reference updating mechanism" and subsequently the "card table address" because the "garbage collector" promotes objects based on the marked card table which is in turn based on the "card table address."*

42. **Claim 18 is rejected under 35 U.S.C. 103(a) as being obvious over Nagarajan in view of Borman as applied to claim 12 above, and in further view of Alpern.**

43. Nagarajan/Borman disclose all the limitations of claim 18 except tracking is performed on an initial access to the card table memory and not upon subsequent accesses to the card table memory.

Alpern discloses tracking is performed on an initial access to the card table memory and not upon subsequent accesses to the card table memory (col. 9, lines 10-15; Fig. 7, element 710).

Nagarajan/Borman and Alpern are analogous art because they are from the same field of endeavor, that being garbage collection.

At the time of the invention it would have been obvious to a person of ordinary skill in the art to implement Alpern's barrier bit within Nagarajan/Borman's garbage collector.

The motivation for doing so would have been to increase system efficiency and decrease system size by having a barrier bit associated with each object to differentiate generations in the generational garbage collection scheme and also keeping the write buffer small by eliminating duplicate entries (Alpern, col. 5, lines 34-36 and 44-45).

Therefore, it would have been obvious to combine Nagarajan/Borman and Alpern for the benefit of obtaining the invention as specified in claim 18.

### **Conclusion**

### **STATUS OF CLAIMS IN THE APPLICATION**

The following is a summary of the treatment and status of all claims in the application as recommended by MPEP 707.70(i):

### **CLAIMS REJECTED IN THE APPLICATION**

Per the instant office action, **claims 1-24** have received a first action on the merits and are subject of a first action non-final.

**RELEVANT ART CITED BY THE EXAMINER**

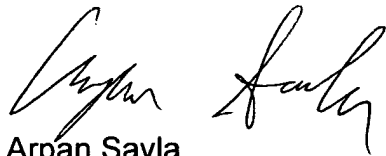
The following prior art made of record and not relied upon is cited to establish the level of skill in Applicant's art and those arts considered reasonably pertinent to Applicant's disclosure. See MPEP 707.05(e).

1. U.S. Patent 5,920,876 discloses performing exact garbage collection using bitmaps that identify pointer values within objects.
2. U.S. Patent 6,148,310 discloses a method for combining card marking with remembered sets for old area of a memory heap.
3. U.S. Patent 6,173,294 discloses a method for combining card marking with remembered set for generation garbage collection with more than two generations.
4. U.S. Patent 6,185,581 discloses a train-algorithm-based garbage collector employing fixed-size remembered sets.
5. U.S. Patent 6,928,460 discloses a method and apparatus for performing generational garbage collection in a segmented heap (U.S. Patent of Nagarajan et al., U.S. Patent Application Publication 2004/0003014).
6. Non-patent literature Tanenbaum, Andrew S., "Structured Computer Organization", 1984, Prentice-Hall, Inc., 2nd Edition, pp. 10-12.


Any inquiry concerning this communication or earlier communications from the examiner should be directed to Arpan P. Savla whose telephone number is (571) 272-1077. The examiner can normally be reached on M-F 8:30-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Donald Sparks can be reached on (571) 272-4201. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



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